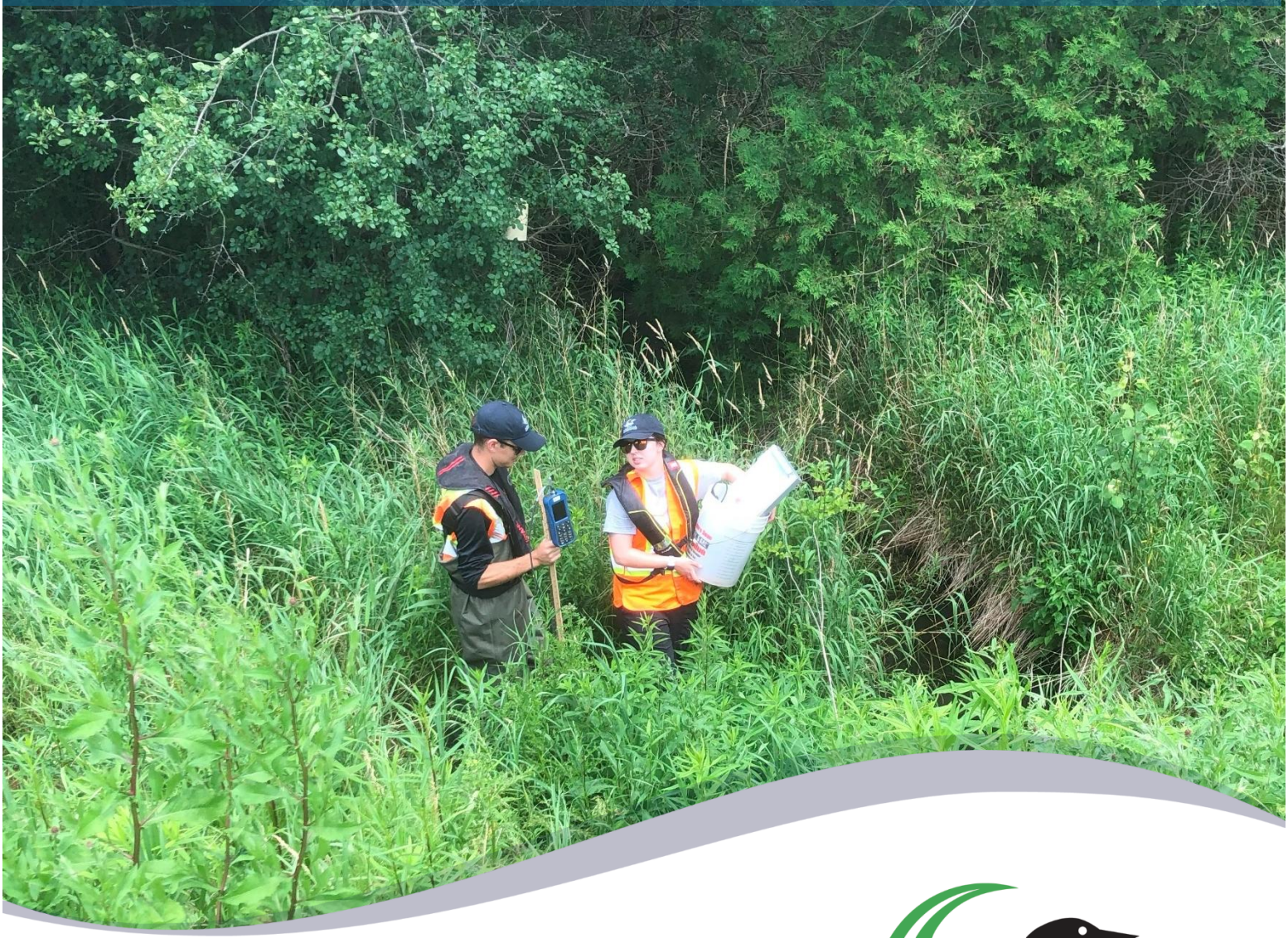
# Companion Document:

## Region of Durham - Investigative Upstream Monitoring Report for Blackstock Creek and East Cross Creek

2025



KAWARTHA CONSERVATION

Discover · Protect · Restore

# About Kawartha Conservation

## Who we are

We are a watershed-based organization that uses planning, stewardship, science, and conservation lands management to protect and sustain outstanding water quality and quantity supported by healthy landscapes.

## Why is watershed management important?

Abundant, clean water is the lifeblood of the Kawarthas. It is essential for our quality of life, health, and continued prosperity. It supplies our drinking water, maintains property values, sustains an agricultural industry, and contributes to a tourism-based economy that relies on recreational boating, fishing, and swimming. Our programs and services promote an integrated watershed approach that balance human, environmental, and economic needs.

## The community we support

We focus our programs and services within the natural boundaries of the Kawartha watershed, which extend from Lake Scugog in the southwest and Pigeon Lake in the east, to Balsam Lake in the northwest and Crystal Lake in the northeast – a total of 2,563 square kilometers.

## Our history and governance

In 1979, we were established by our municipal partners under the *Ontario Conservation Authorities Act*.

The natural boundaries of our watershed overlap the six municipalities that govern Kawartha Conservation through representation on our Board of Directors. Our municipal partners include the City of Kawartha Lakes, Region of Durham, Township of Scugog, Township of Brock, Municipality of Clarington, Municipa wnship of Cavan Monaghan.

KAWARTHA CONSERVATION

Discover • Protect • Restore

**Kawartha Conservation**
277 Kenrei Road, Lindsay ON K9V 4R1
T: 705.328.2271 F: 705.328.2286
GenInfo@KawarthaConservation.com

# Acknowledgements

We would like to acknowledge that many Indigenous Nations have longstanding relationships, both historic and modern, with the territories upon which we are located.

Today, this area is home to many Indigenous peoples from across Turtle Island. We acknowledge that our watershed forms a part of the treaty and traditional territory of the south-eastern Anishinaabeg.

It is on these ancestral and Treaty lands that we live and work. To honour this legacy, we commit to being stewards of the natural environment and undertake to have a relationship of respect with our Treaty partners.

The region of Kawartha Lakes was referred to as Gau-wautae-gummauh, a glistening body of water, inanishinaabemowin. We are thankful to have an opportunity to work with Indigenous Peoples in the continued stewardship and care of this beautiful region.

This plan was written by Matthew Wilson, Assistant Watershed Resource Technician with support from Tanner Liang, Water Quality Specialist. Hydrology results were obtained through the Oak Ridges Morain Groundwater Monitoring Program. Others that have contributed to this project include:

| | |
|---|---|
| Robert Stavinga, Fmr. Watershed Resource Technician | Kawartha Conservation |
| Iryna Shulyarenko, Hydrometric Specialist | Ministry of Natural Resources |
| Nathan Rajevski, Watershed Resource Technician | Kawartha Conservation |
| Nancy Aspden, Director, Integrated Watershed Management | Kawartha Conservation |
| Korey Hayes, GIS Specialist | Kawartha Conservation |
| Anita Caven, Marketing and Communications Assistant | Kawartha Conservation |
| Matthew Wilson, Assistant Watershed Resource Technician | Kawartha Conservation |
| Olivia Vaughan, Fmr. Environmental Field Technician | Kawartha Conservation |
| Theodor Sterescu, Fmr. Environmental Field Technician | Kawartha Conservation |
| Mareike Peveril, Fmr. Environmental Field Technician | Kawartha Conservation |
| Theodor Sterescu, Fmr. Environmental Field Technician | Kawartha Conservation |
| Private Landowner Upstream of site UEC4 | |

Funding for this project was provided by the Region of Durham.

This report may be cited as:
Kawartha Conservation. 2025. Companion Document: Durham Region - Investigative Upstream Monitoring – Blackstock Creek and East Cross Creek. Kawartha Conservation, Lindsay, Ontario. pp 16+ appendices

## Project Background

In 2012, Kawartha Conservation initiated monitoring of the Blackstock Creek and East Cross Creek watersheds to compliment 2010's Lake Scugog Environmental Management Plan (LSEMP) (Kawartha Conservation, 2010). The LSEMP program's main goals were to characterize the watershed surrounding Lake Scugog and to propose solutions to any issues that were found to be affecting water quality.

Blackstock Creek, Cawkers Creek, Layton River and the Nonquon River were identified as streams of concern as they showed phosphorus levels higher than the provincial objective (Kawartha Conservation, 2010). Thus the investigative upstream monitoring program was established to look at more local areas of concerns. This was completed for Cawkers Creek and Williams Creek in 2023 (Kawartha Conservation, 2023a), and Layton River in 2024 (Kawartha Conservation, 2024). In 2024, Kawartha Conservation moved into Blackstock and East Cross creeks, which this report encompasses.

Main objectives of this report are to identify sites with elevated contaminant input and to assess water quality trends in comparison with historical data.

## Methods

### Study Area

The Blackstock Creek and East Cross Creek watersheds are found in southcentral Ontario, with their headwaters originating in the Oak Ridges Moraine, an ecologically and agriculturally important landform. Monitoring took place in 2024 from April to November at 13 sites across both watersheds within the Region of Durham (**Figure 1**).

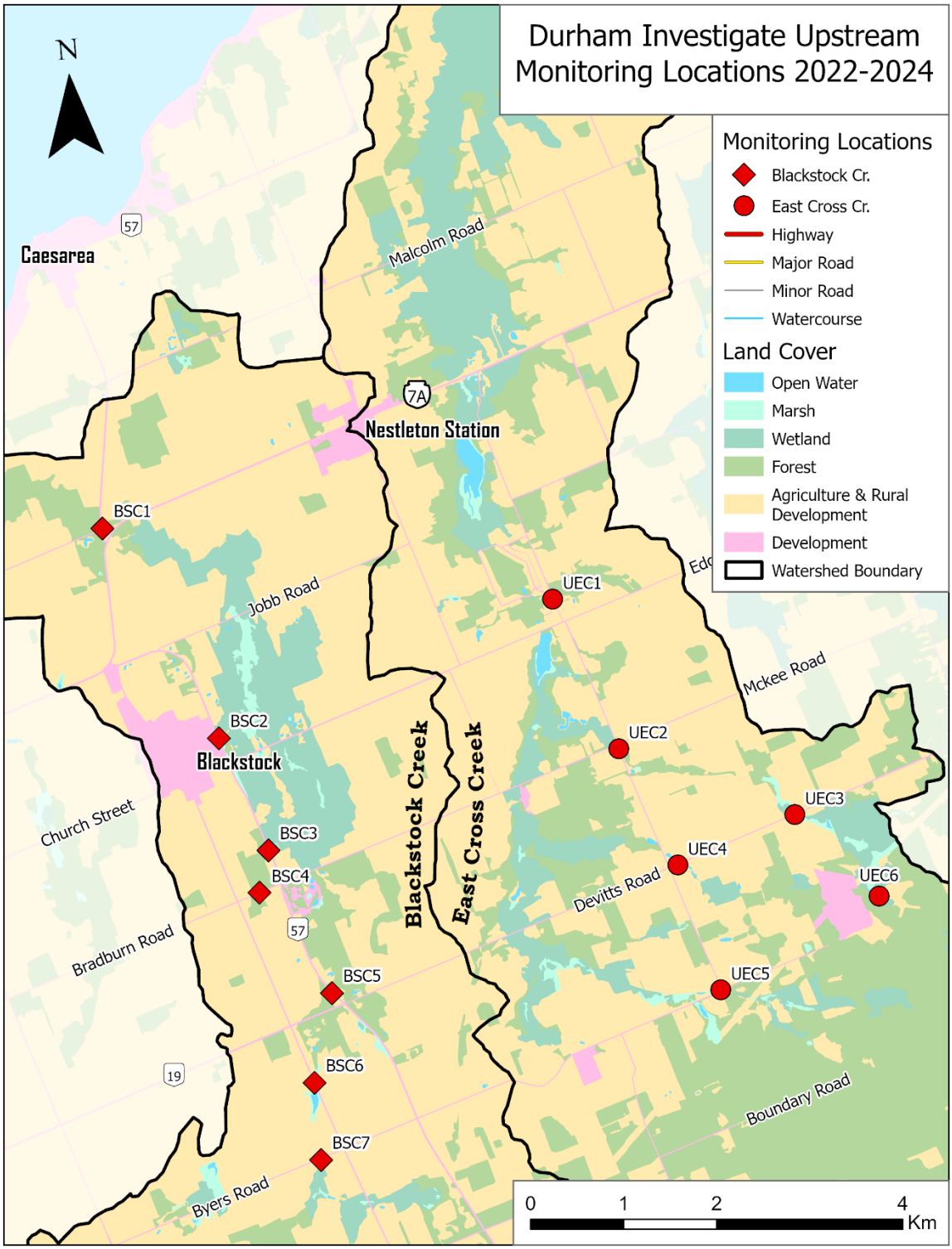



**Figure 1.** Map of the Blackstock and East Cross Creek watershed and their monitoring sites. General land use is also shown.

### Water Quaity

At each site, surface water samples were collected, and the water quality parameters temperature, pH, conductivity, dissolved oxygen and turbidity were assessed using a water quality meter (YSI ProDSS). Water samples were then sent to Caduceon Laboratories Inc. for chemical analysis of nitrogen, phosphorus, metals and total suspended solids.

## Results and Discussion

### Landuse

The land use surrounding these watersheds was found to be mainly agricultural, with natural features and low urban development (**Figure 1**). Sites in the Blackstock Creek watershed had approximately 60% agricultural land use, 21% natural features, with the village of Blackstock accounting for the majority of urban development present. The East Cross Creek watershed's land use was dominated by natural features such as Kawartha Conservation's Durham East Cross Forest Conservation Area at approximately 57% with agricultural use at around 41%.

### Hydrology

Hydrology is the scientific study of the movement, distribution and management of water. Within streams, discharge is the measurement of volumetric flow rate, which tells us the amount of water, along with what it may be carrying, passing through the stream.

When compared against the long-term average (2006-2024), flow rates from Blackstock Creek during the monitoring period of 2021 to 2024 was found to be above average which can be attributed to more rain events during the spring and summer months.

During the monitoring period, the month of March had the highest flow rates, coinciding with the spring melt; other variable periods that had higher flow rates included mid-winter thaw during January, the continuation of spring melt in April and intense storms during the summer months (**Figure 2**). It usually takes about 2 to 4 days from high levels (mean daily discharge more than 1 cubic meter per second) for discharge to return to normal flow rates.

Baseflow is when flow is influence by groundwater only and happens during a period of no precipitation. For Blackstock Creek, this usually occurred during August and September. November and December also exhibit low discharge (**Figure 2**).

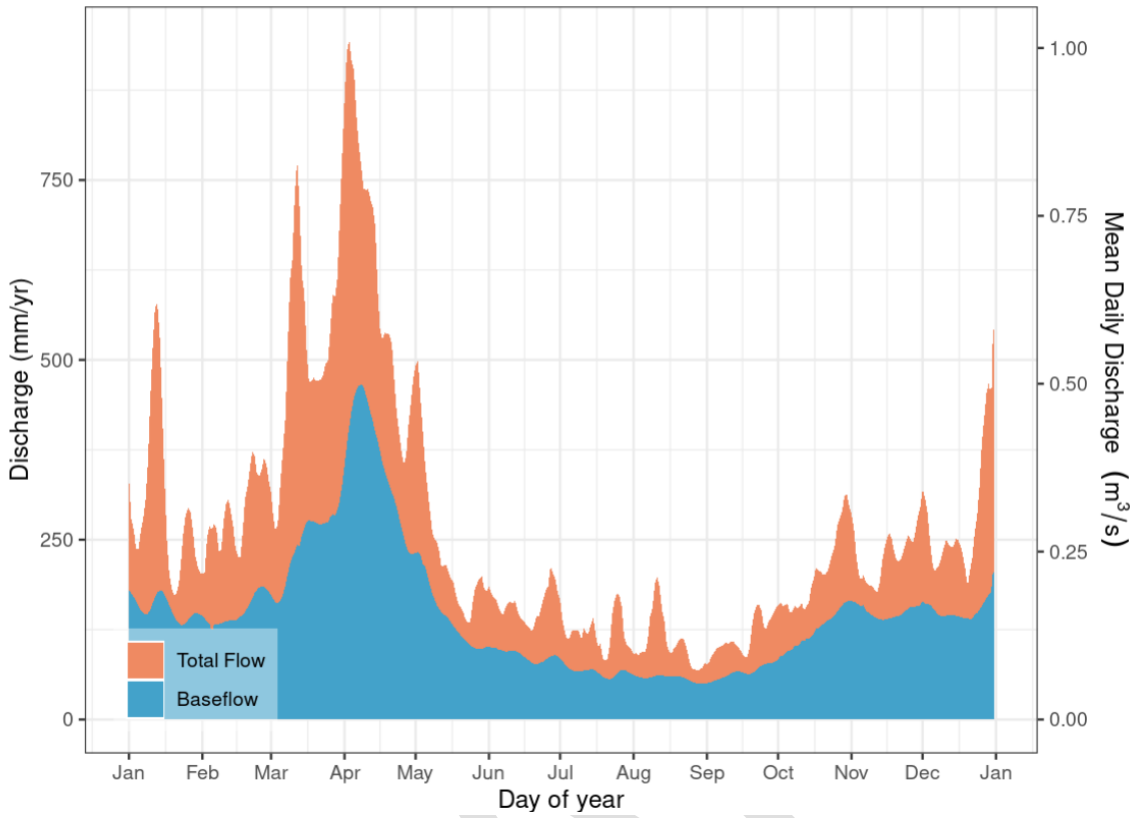



**Figure 2**. Flow rates ($m^3/s$) split between total and baseflow at BSC1. Graph obtained through Oak Ridges Moraine Groundwater Program (2022).

## Water Quality

### Water Temperature and Dissolved Oxygen

Blackstock Creek and East Cross Creek are classified as coolwater/coldwater streams, holding higher amounts of dissolved oxygen (DO), and sensitive species such as Brook Trout (*Salvelinus fontinalis*) and Mottled Sculpin (*Cottus bairdii*) can be found in their waters. For these fish species, high oxygen levels are required during the spawning months for proper egg incubation and juvenile stages.

When the two creeks are compared, Blackstock Creek was found to have lower dissolved oxygen levels than East Cross Creek. Lower DO levels were observed in the headwaters of Blackstock Creek, which along with increased water temperature, could possibly restrict the movement of coldwater fish species. Sites BSC3 and BSC4 on Blackstock Creek showed low dissolved oxygen and higher exceedances (**Table 1**). This is of concerned as there are known populations of sensitive coldwater fish species (Brook Trout and Mottled Sculpin) found downstream (Kawartha Conservation, 2025); these sites should be managed properly as a coldwater stream.

At most sites, during June and July, dissolved oxygen was found to be below the Canadian Water Quality Guideline of 9.5 milligrams per liter (CCME, 1999), which could have negative impacts on the incubation of mottled sculpin eggs.

Increased agricultural land use and reduced natural cover have resulted in lower DO levels at 2 sites (BSC7 and UEC2) when data between years (2006 to 2010 vs 2022 to 2024) is compared; coupled with warmer water due to climate change, habitat for coldwater fish species is reduced, which can alter the composition of fish species found in these streams.

## Water pH

Water pH is a measure of hydrogen ion concentration in water and specifies the acidity or alkaline of a solution, with 1 being the most acidic, 7 being neutral and 14 being the most basic. According to the Provincial Water Quality Objective, an acceptable water pH range is between 6.5 and 8.5 (MOEE, 1994). Throughout the course of monitoring Blackstock and East Cross Creeks we had five measurements that exceeded 8.5 and did not meet the provincial criteria. These exceedances represent a small number (1.3%) of the total readings and there is no concern for the overall pH of the watersheds (**Table 1**). Both streams showed an increase of pH from the headwaters and between the two monitoring time periods, owing to the influence of the underlying limestone geology which produces more alkaline water.

**Table 1.** Failed percentages (%) for each site and for water pH, dissolved oxygen, turbidity, total suspended solids, chloride, nitrate, total phosphorus, aluminum, and iron. Each water quality parameter is compared against the Provincial Water Quality Objectives or the Canadian Water Quality Guidelines.

| Station | Dissolved Oxygen | pH | Turbidity | Chloride | Nitrate | Total Phosphorus | Suspended Solids | Aluminum | Iron |
|---|---|---|---|---|---|---|---|---|---|
| BSC1 | 0 | 2.1 | 0 | 0 | 40.5 | 43.9 | 0 | 7.4 | 15.8 |
| BSC2 | 6.7 | 0 | 6.7 | 76.7 | 6.7 | 96.7 | 3.3 | 8 | 3.7 |
| BSC3 | 0 | 0 | 3.3 | 0 | 96.7 | 3.3 | 0 | 8 | 4.3 |
| BSC4 | 0 | 0 | 3.4 | 0 | 96.4 | 0 | 0 | 4 | 8.7 |
| BSC5 | 0 | 0 | 3.3 | 3.1 | 62.5 | 28.1 | 0 | 8 | 13 |
| BSC6 | 17.4 | 8.7 | 8.7 | 0 | 0 | 69.6 | 4.3 | 15 | 9.1 |
| BSC7 | 52 | 4 | 12 | 0 | 0 | 73.1 | 3.8 | 0 | 4.8 |
| UEC1 | 3.7 | 0 | 0 | 3.7 | 77.8 | 3.7 | 0 | 16 | 27.3 |
| UEC2 | 0 | 0 | 0 | 0 | 89.7 | 13.8 | 0 | 4.2 | 30.4 |
| UEC3 | 12.9 | 0 | 16.1 | 0 | 6.5 | 16.1 | 3.2 | 0 | 31.8 |
| UEC4 | 7.4 | 0 | 0 | 0 | 0 | 14.3 | 3.6 | 4.2 | 60.9 |
| UEC5 | 0 | 0 | 3.2 | 0 | 3.3 | 36.7 | 6.7 | 8 | 63.2 |
| UEC6 | 3.3 | 3.3 | 20 | 0 | 0 | 71.9 | 25 | 62.5 | 66.7 |

## Conductivity and Chloride

Conductivity is a measurement of dissolved salts, such as chlorides, in water. Chlorides in water are a common side effect of human activity such as dust suppression or winter salting of roads. Increased chloride can have a detrimental effect on or kill freshwater organism such as fish, amphibians and invertebrates.

Chloride levels across all sites except one (BSC2; **Figure 1**) were generally below the Canadian Water Quality Guidelines' long-term threshold of 120 milligrams per litre (CCME, 2011) and within the natural range of 10 to 30 milligrams per litre found across Canada (McNeeely and Neimanis, 1979; Evans and Drickl, 2010).

Site BSC1 has shown a long-term trend (2004-2024) of increasing conductivity and chloride levels, increasing significantly since 2009-2010 with levels being consistently higher in the last five years. Although chloride levels are still below the Canadian Water Quality Guidelines threshold of 120 milligrams per litre, it is expected that continued human activity with push chloride levels beyond this threshold.

## Phosphorus

Phosphorus is a chemical element and essential nutrient for plant growth and works its way up the food chain where it is important for other organisms. Too much phosphorus, which can come from agricultural runoff, can cause eutrophication, the rapid expansion of algae growth in bodies of water. When this large mass of algae dies the bacteria which break it down use the available oxygen in the water, leading to decreased dissolved oxygen levels which can negatively impact animal life and drinking water. To control eutrophication, the Provincial Water Quality Objectives is set at 0.03 milligrams per litre for streams and rivers (MOEE, 1994).

Phosphorus levels across both watersheds show a decreasing trend from upstream to downstream. Higher phosphorus levels and exceedances were found at sites UEC6 and UEC5 (**Table 1**) on East Cross Creek, which coincides with the natural cover that dominates those sites. Site BSC7 on Blackstock Creek, a site with mainly agricultural land use, also showed an increase in phosphorus.

## Nitrate

Nitrogen is also a chemical element that is also an essential nutrient for plant growth, which in excess can lead to eutrophication. Ammonia and nitrate are nitrogen containing compounds which can be deposited in the environment as part of artificial fertilizers. High levels of ammonia can accumulate in aquatic organisms, leading to harm or death. High nitrate levels in water lead to reduced dissolved oxygen and can be toxic to humans and animals. The Canadian Water Quality Guidelines for nitrate is set at 3 milligrams per litre (CCME, 2012).

Nitrate were lowest at the headwaters for both creeks, increasing downstream. Sites BSC4 and BSC5 showed elevated levels (**Table 1**), with BSC4 being identified as a nitrate hotspot (**Figure 1**). East Cross Creek had site UEC2 consistently high in nitrate, and also identified as a hotspot (**Figure 1, 3**). BSC4 and UEC2 are primarily fed by groundwater and the increased nitrate levels may be a reflection of nitrogen rich fertilizer which has infiltrated the groundwater.

Ammonia was measured as part of this program, but most results were below the detection limit, with the highest results being below Provincial Water Quality Objectives and Canadian Water Quality Guidelines.

## Water Clarity

Turbidity and Total Suspended Solids are measures of water clarity; turbidity being a measure of the cloudiness based on the amount of light scattering in the water, and Total Suspended Solids being a measure of the concentration of solids that are floating in the water. In general, poor water quality is as associated with a high amounts of suspended solids and murkiness as they are associated with erosion, the discharge of effluent, eutrophication, and environmental disasters.

Thresholds set by the Canadian Water Quality Guideline for the protection of aquatic fife for water clarity are set at 8 Nephelometric Turbidity unit (plus background) for turbidity and 25 milligrams per litre (plus background) for Total Suspended Solids (CCME, 2010). Previous studies (Maude and Maio, 1996; Culp et al., 2013; Kawartha Conservation, 2023b) have measured these background levels, and thresholds for Blackstock and East Cross creeks were set at 10.25 Nephelometric Turbidity unit for turbidity and 28.5 milligrams per litre for Total Suspended Solids. In general readings of turbidity and TSS for the sites monitored fell below the set thresholds, indicating clear water (**Table 1**).

## Metals

Metal elements monitored for this program were Aluminum, calcium, iron, magnesium and sodium. Aluminum and iron are two of the most common elements in the earth's crust and are commonly associated with soil inputs. Other sources include stormwater runoff from roadways, being from unpaved roads or vehicles.

Exceedances for aluminum and/or iron were found across all sites, with UEC6 and UEC5 being the highest (**Table 1**). UEC6 is found in an undisturbed conservation area (**Figure 1**), and the high levels may not be caused by human disturbance but due to localized natural sources such as groundwater, representing naturally elevated levels.

BSC2 and BSC6 show iron levels in exceedance of the threshold (**Figure 1, 4**) and are found downstream from urban development and intensive agriculture; high iron levels may be due to run

off during storm events. These sites can be considered iron hot spots and remedial action should focus on the capture and infiltration of stormwater.

## Nutrient Limitation

Nitrogen and phosphorus are essential nutrients for the growth of plants and animals, and knowing which element is the limiting factor for plant growth in an environment allows us to better manage nutrient input into our streams. For Blackstock and East Cross creeks, it was calculated that both are phosphorus limited systems, meaning that remediation and stewardship efforts should focus on sources of phosphorus input, while also targeting nitrate hot spots at BSC4 and UEC2 (**Figure 1,3**).

## Water Quality Index

The Water Quality Index published by the Canadian Water Quality Guideline (CCME, 2017) offers a way to present complex water quality data in an easy to digest manner. For each site monitored, the following parameters were given a score: dissolved oxygen, nitrate, ammonia, total Kjeldahl nitrogen (the total organic nitrogen including ammonia and ammonium in a sample), total suspended solids, turbidity, pH, total phosphorus, chloride, aluminum and iron. According to the Water Quality Index, many sites score between Fair and Marginal (**Table 1**), indicating that water quality frequently strays from natural levels, with nitrate, phosphorus, total Kjeldahl nitrogen and iron being parameters of concern.

**Table 2.** Water quality index scores and associated category per site are shown.

| Site | CCME WQI | WQI Category |
|---|---|---|
| BSC1 | 70 | Fair |
| BSC2 | 44 | Poor |
| BSC3 | 72 | Fair |
| BSC4 | 77 | Fair |
| BSC5 | 62.3 | Marginal |
| BSC6 | 55.2 | Marginal |
| BSC7 | 58.9 | Marginal |
| UEC1 | 62.5 | Marginal |
| UEC2 | 72 | Fair |
| UEC3 | 62.6 | Marginal |
| UEC4 | 66 | Fair |
| UEC5 | 62.5 | Marginal |
| UEC6 | 43 | Poor |

## Drivers of water Quality

Through statistical analysis the following trends and patterns between water quality parameters, land cover and weather conditions were found:

- The application of salts has a large impact on BSC2.
- Elevated total phosphorus and total Kjeldahl nitrogen inputs have similar sources and are somewhat driven by agricultural land use.
- A nitrate signal unique to BSC4 and UEC2 can be detected.
- DO reduction is caused by an increase in agricultural land use and total phosphorus levels, with warm water temperatures and reduced water quality being characteristic of low DO levels.

## Hydrology

In March and April during the spring melt there was high water flows (over 0.5 cubic meters per second), causing an increase in the loading of chloride, nitrate and a lesser extent phosphorus. Base flow (around 0.03 cubic meters per second) occurred during August and September, with storms facilitating periods of high flow during otherwise low flow conditions, leading to higher loads of phosphorus and total suspended solids. Flow rates generally return to normal within 2 to 4 days.

## Conclusion

Through our monitoring it was shown that land use activities adjacent to Blackstock Creek and East Cross Creek have impacted the water quality at several sites, with BSC4 and UEC2 showing elevated nitrate levels, BSC2 showing an increase in chloride and BSC5 exhibiting increased phosphorus. With this knowledge in hand, these sites have been identified as key candidates for water quality enhancement projects. Although water quality results indicated that UEC6 had *poor* water quality, the site characteristics (groundwater seep in an organic wetland and surrounding mature forest) observed did not suggest that this site was heavily degraded. Sites along East Cross Creek were identified as important background sites (showing little impact), with UEC5 located within Durham East Cross Forest Conservation Area being a prime candidate for long-term monitoring as a reference site. When compared to previous monitoring data from 2004 onward, sites at the lower part of Blackstock Creek showed a significant increase of chloride and nitrate levels, with phosphorus, aluminum and iron being stable, which is consistent with urban expansion and agricultural intensification.

With degraded water quality and seasonally unavailable water in the upper region of Blackstock Creek and urban development at the lower part of the watershed, there is concern that sensitive

aquatic species will be confined to the central portion. Stewardship and remediation efforts should focus on creating and maintaining connectivity along this passage.

# Reference

CCME - Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Dissolved oxygen (freshwater). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME - Canadian Council of Ministers of the Environment. 2002. Canadian water quality guidelines for the protection of aquatic life: Total particulate matter. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME - Canadian Council of Ministers of the Environment. 2011. Canadian water quality guidelines for the protection of aquatic life: Chloride. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME - Canadian Council of Ministers of the Environment. 2012. Canadian water quality guidelines for the protection of aquatic life: Nitrate. In: Canadian environmental quality guidelines, Canadian Council of Ministers of the Environment, Winnipeg.

CCME - Canadian Council of Ministers of the Environment. 2017. Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index, User's Manual – 2017 Update. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Culp, J.M., Brua, R.B., Benoy, G.A. and Chambers, P.A., 2013. Development of reference conditions for suspended solids in streams. Canadian Water Resources Journal, 38(2), pp.85-98.

Evans, M., and Frick, C. 2001. The Effects of Road Salts on Aquatic Ecosystems. NWRI Contribution No. 02-308. Environment Canada, National Water Research Institute, Saskatoon, SK.

Government of Ontario. 2015. Ontario Watershed Information Tool. Provincial Mapping Unit, Mapping and Information Resources Branch, Corporate Management and Information Division, Ministry of Natural Resources and Forestry, Peterborough, Ontario

Kawartha Conservation. 2010. Lake Scugog Environmental Management Plan. Kawartha Conservation, Lindsay, Ontario

Kawartha Conservation. 2023a. Region of Durham - Investigative Upstream Monitoring Report for Cawkers Creek and Williams Creek. Kawartha Conservation, Lindsay, Ontario.

Kawartha Conservation. 2023b. City of Kawartha Lakes – Turbidity and Total Suspended Solids Survey. Kawartha Conservation, Lindsay, Ontario. pp 27+ appendices

Kawartha Conservation. 2024. Region of Durham - Investigative Upstream Monitoring Report for Layton River. Kawartha Conservation, Lindsay, Ontario.

Kawartha Conservation. 2025. Durham Watershed Planning – 2024 Activities Summary Report. Kawartha Conservation, Lindsay, Ontario.

Maude, S.H. and Di Maio, J., 1996. Benthic macroinvertebrate communities and water quality of headwater streams of the Oak Ridges Moraine: reference conditions.

McNeely, R.N., Neimanis, V.P., Dwlyer, L. 1979. Water Quality Sourcebook: A Guide to Water Quality Parameter. Inland waters Directorate, Water Quality Branch, Environment Canada, Ottawa, Canada.

MOEE - Ontario Ministry of the Environment and Energy. 1994. Water management: policies, guidelines, provincial water quality objectives - Provincial Water Quality Objectives. Queen's Printer for Ontario. Ministry of the Environment and Energy

Oak Ridges Moraine Groundwater Program. (2022). Database Snapshots [Data set]. https://github.com/OWRC/snapshots

KAWARTHA CONSERVATION

Discover • Protect • Restore

**Kawartha Conservation**
277 Kenrei Road, Lindsay ON  K9V 4R1
T: 705.328.2271  F: 705.328.2286
GenInfo@KawarthaConservation.com
**KawarthaConservation.com**